Marine mammal monitoring and mitigation during recent seismic surveys for geophysical research

W.J. Richardson,* M. Holst,* W.R. Koski,* M.A. Smultea,* and M. Rawson**

* LGL Ltd., environmental research associates, POB 280, King City, Ont. L7B 1A6, Canada (wjr@lgl.com)

** Lamont-Doherty Earth Observatory of Columbia University, POB 1000, Palisades, NY 10964, U.S.A.

Abstract

The R/V *Maurice Ewing*, operated by Lamont-Doherty Earth Observatory of Columbia University, conducts academic marine seismic surveys sponsored by the U.S. National Science Foundation. In autumn 2002, a beaked whale stranding occurred in Baja California when the *Ewing* was operating its largest airgun configuration (20 guns; 8600 in^3) nearby. No causal link was confirmed. However, subsequent *Ewing* seismic surveys have included progressively more stringent monitoring and mitigation measures under provisions of Incidental Harassment Authorizations issued by the U.S. National Marine Fisheries Service (NMFS). ***Monitoring*** includes visual observations by trained marine mammal observers during all daytime airgun operations and during nighttime ramp-ups, when allowed. Starting in 2004, a towed hydrophone array is monitored day and night for cetacean calls when the larger airgun configurations are used. ***Pre-cruise mitigation*** includes selecting the smallest airgun array consistent with the geophysics objectives and, where possible, adjusting plans to avoid seasons and/or locations of special concern for marine mammals, sea turtles, and most recently fisheries. ***Mitigation during cruises*** includes ramp-ups, plus power-downs (to one small airgun) or shut-downs when mammals and (recently) sea turtles are detected within a "safety radius": the 180 dB re 1 μPa (rms) distance for cetaceans and sea turtles, and the 190 dB radius for pinnipeds. Specific rules determine when airgun operations can resume after a shut-down or power-down. ***Acoustic measurements*** showed that the safety radii are greater in shallow than deep water. Recently, depth-dependent safety radii have been applied, and other mitigation measures have been more stringent in shallow waters. ***Conclusions:*** No one monitoring or mitigation measure is entirely effective in detecting marine mammals or avoiding their exposure to strong airgun sounds. However, different monitoring and mitigation techniques can be complementary. In judiciously-chosen combinations, they can substantially reduce the likelihood of biologically-significant effects. These benefits have costs to the seismic operator.